Functional Groups: Clarifying Our Use of the Term

In an attempt to understand and predict how global environmental changes may influence the structure and function of natural ecosystems, ecologists have begun to look for ways to assemble species into functionally significant groups. Given the huge number of species that exist on the Earth, there is clearly a need to simplify natural communities in order to develop scenarios of future ecosystem change. Grouping species in particular ways may help us better understand how species composition will be altered by multiple environmental perturbations, and how changes in community structure are linked to ecosystem processes. Due to the relative newness of this field of ecology, some of the terms adopted are not clearly defined or have been used in multiple ways. Here, I highlight one particular case where we need to clarify our terminology and suggest a way to do so.

The problem

The terms *functional group* and *functional type* have been used increasingly to consider the potential influence of global environmental changes on community dynamics and ecosystem function. The two terms are now used interchangeably in the literature. This, in itself, does not present a significant problem. However, there is confusion over the meaning of the words, because ecologists are using them to refer to two very different ways of grouping species. The dichotomy reflects whether species affect or are affected by changes in their environment (Fig. 1).

A) Responses to the environment. The term *functional group* is often used to refer to species that respond in similar ways to particular environmental perturbations. For example, it is now clear that the photosynthetic pathway that plants use to fix CO_2 may strongly affect the way they respond to future elevated levels of atmospheric CO_2 concentrations. In general, C_3 plants show much higher photosynthetic enhancements in elevated CO_2 than do C_4 plants. Grouping plants on the basis of potential responses to environmental changes has proved particularly useful for the development of models addressing the influence of global climate change on vegetation composition.

B) Ecosystem effects. Alternatively, *functional groups* refer to sets of species that have similar effects on specific ecosystem processes. For example, all nitrogen-fixing plant species could be placed in the same functional group, as these species represent a primary pathway by which nitrogen enters ecosystems from the atmosphere. Use of *functional group* in the "ecosystem effect" sense emphasizes the roles species play in system-level processes, and as a result provides a link between community composition and ecosystem function. Loss of all the species within a functional group would clearly have a large and direct impact on ecosystem processes.

There are now good methods for recognizing both kinds of grouping in natural systems. Species are grouped together because they share common traits, and as a result behave analogously. Species that respond in equivalent ways to environmental changes can be recognized using multivariate techniques that distinguish clusters of similar species based on morphological, physiological, and life history data. In order to group species on the basis of their roles in ecosystem processes, particular attributes of organisms can be identified that have a significant role in the movement of energy and material into, through, and out of ecosystems.

A solution

I believe that both definitions of *functional group* are useful ways of classifying species, but that different terms should be used to distinguish the meanings. The term *functional group* by itself is effective as a hierarchical way of aggregating species, but I suggest that the words *response* or *effect* be added, as appropriate, to clarify usage. Thus, *functional response groups* would include species that respond in the same way to specific environmental perturbations, while *functional effect groups* would refer to species that have similar effects on ecosystem-level processes. In the appropriate context, ecologists may wish to drop the word *functional* and consider *response groups* and *effect groups*.

Even distinguishing different ways of grouping species may not prevent ambiguity in the use of the terms *functional response groups* and *functional effect groups*. The composition of any particular group may vary depending on the processes of interest and the level of refinement required. For example, if we are concerned with total carbon flux through a forest, all canopy tree species may

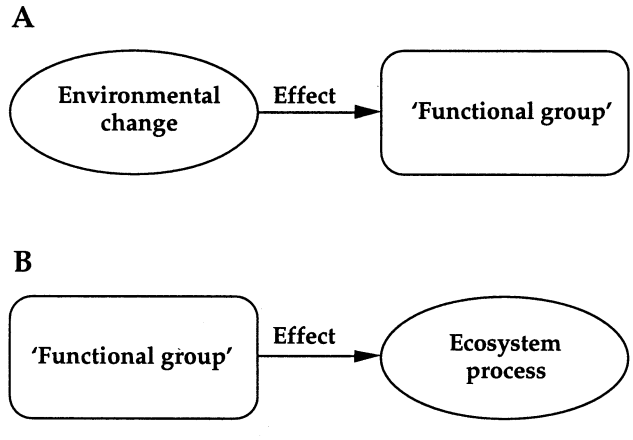

Fig. 1. The two ways the term *functional group* is currently used by ecologists. The different uses are discussed in the text.

be placed in one *functional effect group*. However, if the process of interest is intra-annual variation in carbon flux, deciduous and evergreen species should be distinguished. For further clarity, we should also identify the particular environmental perturbations (for *response group*) and ecosystem properties (for *effect group*) that are relevant to the issue at hand. For example, the C_3/C_4 dichotomy that identifies *functional response groups* with regard to elevated CO_2 may not be appropriate for distinguishing groups that differ in their response to increased nitrogen deposition.

Ecology is already full of terminology. Why do we need more? I believe that, in the case of *functional groups*, clarifying our use of the term will provide a more cohesive framework for understanding how global environmental changes will influence the structure and function of natural ecosystems. The field cannot move forward unless we all understand one another.

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Global Letter to World Leaders from Scientists about Population Growth and Resource Use

Signatures are being gathered from scientists on a letter expressing concern over current trends in human population growth and resource use, and requesting action by world leaders. The letter, and additional information, is available in English, Mandarin Chinese, Spanish, Russian, or Hindi at <http://climate.konza.ksu.edu/~popres/>. All interested scientists are encouraged to visit this Web site or e-mail <popres@climate. konza. ksu.edu> for more information.

Many scientists are concerned with the environmental degradation and negative effects on humans occurring as a result of trends in human population growth and basic resource use, and see this as a central global problem. The letter outlines the inability of technology to solve all the problems caused by the growing population, and appeals to world leaders to develop policies to address these issues in order that all people may enjoy a reasonable standard of living.

Interested scientists are encouraged to print (from the Web page or e-mail) and sign a copy of the letter, and send it to Resources and Human Population, P.O. Box 381, Manhattan, KS 66505-0381 by 1 February 1999. They also are encouraged to obtain additional signatures by distributing the letter in their classes, departments, companies, schools, and professional meetings and by sending copies to their colleagues, friends, and acquaintances.

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Open Letter to World Leaders

We, scientists of the world, are deeply concerned about trends in global population growth and related environmental degradation. Increasing consumption of goods in developed countries, plus rapid growth in the number of humans worldwide, threatens to outstrip the resources of our planet and the ability of our technology to support people with a decent standard of living. It is becoming more difficult to feed, clothe, house, and provide health care for all people, because the amount of natural resources that is potentially available for each individual is decreasing. Population increase is the root cause of much disease, malnutrition, social inequity, loss of biodiversity, and environmental destruction. These problems are inescapable despite our efforts as scientists to help solve the world's problems with new technologies. Land, water, and energy resources must be sustainably managed, consumption reduced, and a significant reduction in the quarter-million people added to the population daily must occur. Clearly, we all are a part of one world, and the people of each nation, along with their leaders, should develop a population policy for their nation. We hope that you will provide the leadership to initiate incentives to reduce family size and conserve natural resources in order to achieve a high standard of living for everyone.

Signed,

Name _____ *Title* _____ *Country* _____